Advanced Clinical Systems in a Hospital Environment: The Brigham Integrated Computing System (BICS)

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The Brigham Integrated Computing System (BICS) is a fully integrated clinical and administrative computing environment for Brigham and Women's Hospital (BWH), a 720-bed teaching affiliate of Harvard Medical School. BICS includes a number of novel systems and features which promote correct, well-informed, cost-effective patient care.

BICS originated as a port of the Beth Israel Hospital (Center for Clinical Computing) MIIS system in 1984; some of the fundamental software still owes its parentage to that system. Independent development has proceeded at BWH since 1988. Realizing that the existing minicomputer platform would not support BWH's continued expansion, the Information Systems department elected to convert the system to an all-microcomputer platform for improved flexibility and performance per dollar. BICS now runs on a network of over 4000 microcomputers, including 120 servers and shadow servers. Over 90 gigabytes of active data are stored on these servers; the data is represented to the software as a single unified database. Due to the low expense of hard disk storage and the space efficiency of Mumps, routine archiving of clinical data is not necessary. BICS handles an average of 40,000 sign-ons daily

A very wide variety of clinical information is available to the clinician using BICS; almost all specimen laboratories and patient studies are reported to the system. One main theme of BICS clinical systems development has been to take this wide array of information and organize it in ways that are logical to the clinician's practice. Such logical information displays, combining information from disparate sources, can make the practice easier and more convenient, and can ensure that the clinician has all of the relevant information needed for a given situation. A second theme has been the use of direct reminders, alerts, and algorithms to promote proper patient care, prevent adverse events, and improve resource utilization.

Major clinical systems developed at BWH include the following:

- The *ambulatory medical record* is a paperless record that has been in use in many of BWH's largest practices since 1989. It includes full notes, problem lists, medications, allergies, and other data. The ambulatory record provides logically combined data displays, such as "patient-at-a-glance" and "day-at-a-glance" displays, health maintenance information and problem-specific flowsheets.
- *Physician order entry* has been in use since 1993, and is now used for all orders on all adult inpatient services, processing some 120,000 orders every week. Ambulatory order entry is being developed for release in 1995. Suggested doses and dose limits, order sets, warnings about dangerous conditions or excessive resource utilization, and consequent orders are used to encourage better quality and consistency of orders. Order entry has been extremely effective in promoting safe, consistent, cost-effective ordering in the hospital.
- Event processing logic in the *Event Engine* senses unusual patterns in data flowing into BICS which may call for urgent action. For example, a new order or lab result may create a drug-lab interaction; or, the passage of a specified period of time without renewal of a patient's daily parenteral-nutrition orders may suggest an oversight on the physician's part. When the event engine detects an unusual condition, it notifies the proper physician automatically, through electronic mail or through the physician's beeper. The computer describes the event to the physician and suggests remedial actions.

Other subsystems and features of importance include the *Handbook* system, a collection of reference information and formulas which can be linked to other programs; *Sign-Out*, a system for communicating patient data among providers which has been shown to prevent adverse events during cross-coverage; and *Coverage List*, a database that continuously tracks the relationship between providers and patients, which underlies many of the above features.

Current projects on BICS include enhancement of the decision-support and quality-of-care features described above, and development of support for BWH's new role as a core hospital in a regional health network.

0195-4210/95/$5.00